Section 958

STANDARD TEST METHOD FOR DETERMINING RUTTING SUSCEPTIBILITY USING THE ASPHALT PAVEMENT ANALYZER

958.01 Scope:

1. This method describes a procedure for testing the rutting susceptibility of asphalt-aggregate mixtures using the Asphalt Pavement Analyzer (APA).

2. This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulations prior to use.

958.02 Referenced Documents

1. AASHTO Standards:

    1.1 T-168 Standard Practice for Sampling Bituminous Paving Mixtures

    1.2 T-166 Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Saturated Surface-Dry Specimens

    1.3 T-209 Standard Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures

    1.4 T-269 Standard Test Method for Percent Air Voids in Compacted Dense and Open Bituminous Mixtures

    1.5 E 178 Standard Practice for Dealing With Outlying Observations

958.03 Apparatus

1. Asphalt Pavement Analyzer (APA) - A thermostatically controlled device designed to test the rutting susceptibility of hot mix asphalt by applying repetitive linear loads to compacted test specimens through pressurized hoses.

    1.1 The APA shall be thermostatically controlled to maintain the test temperature and conditioning chamber at any set point between 40 and 162 °F within 1.8 °F.

    1.2 The APA shall be capable of independently applying loads up to 101 lb to the three wheels. The loads shall be calibrated to the desired test load by an external force transducer.

    1.3 The pressure in the test hoses shall be adjustable and capable of maintaining pressure up to 120 psi.

    1.4 The APA shall be capable of testing three beam specimens simultaneously.

1.5 The APA shall have a programmable master cycle counter which can be preset to the desired number of cycles for a test. The APA shall be capable of automatically stopping the test at the completion of the programmed number of cycles.

1.6 The hoses shall be Gates 77B Paint Spray and Chemical $^{3}/_{4}$ inch, 750 psi W.P. GL 07148. The hoses should be replaced when any of the outer rubber casing has worn through and threads are exposed. Follow the APA manufacturer's instructions for the technique on replacing hoses.

2. Balance, 12,000 gram capacity, accurate to 0.1 gram.

3. Mixing utensils (bowls, spoon, spatula)

4. Ovens for heating aggregate and asphalt cement.

5. Compaction device and molds

958.04 Preparation of Test Specimens

1. Number of test specimens - One test will use either three beam (3 x 5 x 12 inch) specimens or six cylindrical (6 inch diameter x 3 inch) specimens.

2. Roadway Core Specimens

Roadway core specimens shall be 6 inch diameter with all surfaces of the perimeter perpendicular to the surface of the core within 0.2 inches. Cores shall be trimmed with a wet masonry saw to a height of 3 + 0.1 inches.

3. Plant Produced Mixtures

Samples of plant produced mixtures shall be obtained in accordance with AASHTO T 169. Mixture samples shall be reduced to the appropriate test size in accordance with D-979 (ASTM) and compacted while the mixture is still hot. Reheating of loose plant mixture should be avoided.

4. Laboratory Prepared Mixtures

4.1 Required batch sizes are determined in accordance to the Appendix.

4.2 The temperature to which the asphalt binder must be heated to achieve a viscosity of 170 + 20cSt shall be the mixing temperature. For modified asphalt binders, use the mixing temperature recommended by the binder manufacturer.

4.3 Dry mix aggregates and hydrated lime (when lime is used) first, then add optimum percentage of asphalt cement. Mix the materials until all aggregates are thoroughly coated.

4.4 Test samples shall be aged in accordance with the short-term aging procedure in AASHTO PP2

4.5 The temperature to which the asphalt binder must be heated to achieve a viscosity of 290 + 30 cSt shall be the compaction temperature. For modified asphalt binders, use the compaction temperature recommended by the binder manufacturer. The mixture shall not be heated at the compaction temperature for more than one hour.

5. Laboratory Compaction of Specimens

5.1 Laboratory prepared specimens shall be compacted to contain 7.0 ± 1.0% air voids.

5.2 Compacted specimens should be left at room temperature (approximately 77 °F) to allow the entire specimen to cool for a minimum of 3 hours.

958.05 Determining the Air Void Contents

1. Determine the bulk specific gravity of the test specimens in accordance with AASHTO T-166

2. Determine the maximum specific gravity of the test mixture in accordance with AASHTO T-209

3. Determine the air void contents of the test specimens in accordance with AASHTO T-269

958.06 Selecting the Test Temperature

1. For circumstances where the binder grade has been bumped the APA test temperature will remain at the standard PG high temperature.

958.07 Specimen Preheating

1. Place the specimens in the molds.

2. Specimens shall be preheated in the temperature calibrated APA test chamber or a separate calibrated oven for a minimum of 6 hours. Specimens should not be held at elevated temperatures for more than 24 hours prior to testing.

958.08 Procedure

1. Set the hose pressure gage reading to 100 ± 5 psi. Set the load cylinder pressure reading for each wheel to achieve a load of 100 ± 5 lb.

2. Secure the preheated, molded specimens in the APA. The preheated APA chamber should not be opened more than 6 minutes when securing the test specimens into the machine. Close the chamber doors and allow 10 minutes for the temperature to restabilize prior to starting the test.

958.09 Calculations

1. Outlier Evaluation- Arrange the test values in order of increasing magnitude: $x_1 < x_2 < x_3$. If the largest value is the suspected outlier, calculate the T-statistic as follows:

$$T_3 = (x_3 - x)/s$$

If the smallest value is the suspected outlier, calculate the T-statistic as follows:

$$T_1 = (x - x_1)/s$$

where:

x = the average of the three test values
s = the estimate of the population standard deviation based on the sample data, that is, the standard deviation using (n-1) in the denominator.

If the T-statistic is greater than or equal to $T_{critical\ (\alpha = 5\%)} = 1.153$, then there is only one chance in twenty that the value is from the same population as the other values. If the T-statistic is greater than or equal to $T_{critical\ (\alpha = 1\%)} = 1.155$, then there is only one chance in one hundred that the value is from the same population as the other values. Therefore, the aberrant value may be discarded, and the remaining two rut depths averaged to represent the test result when the T-statistic is greater than or equal to 1.155. When this occurs, the testing procedure, device calibration, and test specimens should be investigated to determine possible causes for the excessive variation.

2. The APA rut depth for the mixture is the average of three beam specimens or six cylindrical specimens.

958.10 Report

1. The test report shall include the following information:
   - 1.1 The laboratory name, technician name, and date of test.
   - 1.2 The mixture type and description.
   - 1.3 Specimen type.
   - 1.4 Average air void content of the test specimens.
   - 1.5 The test temperature.
   - 1.6 The average rut depths to the nearest 0.003 inch at 8000 cycles.

958.11 Precision and Bias

Work is underway to develop a precision statement for this standard.

958.12 Calibration

The following items should be checked for calibration no less than once per year: (1) preheating oven, (2) APA temperature, (3) APA wheel load, and (4) APA hose pressure. Instructions for each of these calibration checks is included in this section.

1. Temperature calibration of the preheating oven.

    1.1 The preheating oven must be calibrated with a NIST traceable thermometer (an ASTM 65 C calibrated thermometer is recommended) and a metal thermometer well to avoid rapid heat loss when checking the temperature.

    1.2 Temperature Stability

    Set the oven to the chosen temperature (e.g. 140 °F). Place the thermometer in the well and place them on the center of the shelf where the samples and molds will be preheated. It usually takes an hour or so for the oven chamber, well and thermometer to stabilize. After one hour, open the oven door and read the thermometer without removing it from the well. Record this temperature. Close the oven door.

    Thirty minutes after obtaining the first reading, obtain another reading of the thermometer. Record this temperature. If the readings are withing 0.7 °F, then average the readings. If the readings differ by more than 0.7 °F then continue to take readings every thirty minutes until the temperature stabilizes within 0.7 °F on two consecutive readings.

    1.3 Temperature Uniformity

    To check the uniformity of the temperature in the oven chamber, move the thermometer and well to another location in the oven so that they are on a shelf where samples and molds will be preheated, but as far as possible from the first location. Take and record readings of the thermometer at the second location every thirty minutes until two consecutive readings at the second location are within 0.7 °F.

    Compare the average of the two readings at the first location with the average of the stabilized temperature at the second location. If the average temperatures from the two locations are within 0.7 °F , then the oven temperature is relatively uniform and it is suitable for use preheating APA samples. If the average of the readings at the two locations differ by more than 0.7 °F then you must find another oven that will hold this level of uniformity and meets calibration.

    1.4 Temperature Accuracy

    Average the temperatures from the two locations. If that average temperature is within 0.7 °F of the set point temperature on the oven, then the oven is reasonably accurate and calibration is complete.

If the set point differs from the average temperature by more than 0.7 °F, then adjust the oven set point appropriately to raise or lower the temperature inside the chamber so that the thermometer and well will be at the desired temperature (e.g. 140 °F).

Place the thermometer and well in the center of the shelf. At thirty-minute intervals, take readings of the thermometer. When two consecutive readings are within 0.7 °F, and the average of the two consecutive readings are within 0.7 °F of the desired test temperature (e.g. 140 °F), then the oven has been properly adjusted and calibration is complete. If these two conditions are not met, then repeat the two previous steps.

2. Temperature Calibration of the APA

The APA must be calibrated with a NIST traceable thermometer (an ASTM 65 C calibrated thermometer is recommended) and a metal thermometer well to avoid rapid heat loss when checking the temperature.

2.1 Temperature Stability

Turn on the APA main power and set the chamber temperature controller so that the temperature inside the testing chamber is about 140 °F. Also, set the water temperature controller to achieve approximately 140 °F water temperature. (Note - experience with the APAC APA has shown that it is necessary to set the controller to about 124 °F to achieve a chamber temperature of140 °F.) Place the thermometer in the well and place them on the left side of the shelf where the samples and molds will be tested. (Note - it may be helpful to remove the hose rack from the APA during temperature calibration to avoid breaking the thermometer.)

It usually takes about five hours for the APA to stabilize. After the temperature display on the controller has stabilized, open the chamber doors and read the thermometer without removing it from the well. Record this temperature. Close the chamber doors.

Thirty minutes after obtaining the first reading, obtain another reading of the thermometer. Record this temperature. If the readings are within 0.7 °F, then average the readings. If the readings differ by more than 0.7 °F then continue to take readings every thirty minutes until the temperature stabilizes within 0.7 °F on two consecutive readings.

2.2 Temperature Uniformity

To check the uniformity of the temperature in the APA chamber, move the thermometer and well to the right side of the shelf where the samples are tested. Take and record readings of the thermometer at the second location every thirty

minutes until two consecutive readings at the second location are within 0.7 °F.

Compare the average of the two readings at the left side with the average of the stabilized temperature at the right side. If the average temperatures from the two locations are within 0.7 °F, then the APA temperature is relatively uniform and it is suitable for use. If the average of the readings at the two locations differ by more than 0.7 °F then consult with the manufacturer on improving temperature uniformity.

2.3 Temperature Accuracy

Average the temperatures from the two locations. If that average temperature is within 0.7 °F of the desired temperature of 140 °F, then the APA temperature is reasonably accurate and calibration is complete.

If the average temperature differs from the desired temperature of 140 °F by more than 0.7 °F, then adjust the APA temperature controller so that the thermometer and well will be at the desired temperature of 140 °F.

Place the thermometer and well in the center of shelf. At thirty minute intervals, take readings of the thermometer. When two consecutive readings are within 0.7 °F, and the average of the two consecutive readings are within 0.7 °F of the desired test temperature of 140 °F, then the APA temperature has been properly adjusted and calibration at that temperature is complete. Record the current set points on the temperature controllers for later reference.

3. Wheel Load calibration of the air cylinders at the three test positions

3.1 The APA wheel loads will be checked with the calibrated load cell provided with the APA. The loads will be checked and adjusted one at a time while the other wheels are in the down position and bearing on a dummy sample or wooden block of approximately the same height as a test sample. Calibration of the wheel loads should be accomplished with the APA at room temperature. A sheet is provided to record the calibration loads.

3.2 Remove the hose rack from the APA.

3.3 Jog the wheel carriage until the wheels are over the center of the sample tray when the wheels are in the down position.

3.4 Raise and lower the wheels 20 times to heat up the cylinders.

3.5 Adjust the bar on top of the load cell by screwing it in or out until the total height of the load cell-load bar assembly is 4 inches.

3.6 Position the load cell under one of the wheels. Place wooden blocks or dummy samples under the other two wheels.

3.7 Zero the load cell.

3.8 Lower all wheels by turning the cylinder switch to CAL.

3.9 If the load cell is not centered left to right beneath the wheel, then raise the wheel and adjust the position of the load cell. To determine if the load cell is centered front to back beneath the wheel, unlock the sample tray and move it SLOWLY until the wheel rests in the indentation on the load cell bar (where the screw is located).

3.10 After the load cell has been properly centered, adjust the pressure in the cylinder to obtain 100 lbs. Allow three minutes for the load cell reading to stabilize between adjustments. Record the pressure and the load.

3.11 With the wheel on the load cell remaining in the down position, raise and lower the other wheels one time. Allow three minutes for the load cell reading to stabilize. Record the pressure and the load.

3.12 With the other wheels remaining in the down position, raise and lower the wheel over the load cell. Allow three minutes for the load cell reading to stabilize. Record the pressure and the load.

3.13 Repeat steps 3.6 through 3.11 for each wheel/cylinder.

3.14 Return the load cell to the first wheel and repeat steps 3.6 through 3.11.

3.15 Place the load cell under the second wheel and repeat steps 3.6 through 3.11.

3.16 Place the load cell under the third wheel and repeat steps 3.6 through 3.11. The current cylinder pressures will be used to set wheel loads to 100 lbs.

4. Replacement of the APA hoses.

4.1 New hoses shall be placed in service in accordance with 2.1.6.

4.1.1 Remove the hose rack from the APA.

4.1.2 Remove the used hoses from the hose rack. Place the hoses on the barbed nipples and secure with the hose clamps.

4.1.3 Position the hoses in the rack such that the hose curvature is vertical. Tighten the nuts at the ends of the hoses only until the hoses are secure. Over-tightening will affect the contact pressure and hose life.

4.1.4 Place the hose rack back into the APA and make sure that the hoses are aligned beneath the wheels.

4.1.5 Prior to testing, break in the new hoses by running 8000 cycles on a set of previously tested samples at a temperature of 131°F or higher.

5. APA Hose Pressure Check

The air pressure in the APA test hoses shall be checked with a NIST traceable test gauge or transducer with a suitable range. The check shall be made while the APA is operating. Since the hoses are connected in series, it is satisfactory to connect the test gauge to the end of the right-most hose. The pressure should not fluctuate outside the range of 100 ± 5 psi during normal operation. Adjust the pressure as necessary with the hose pressure regulator.

Note: The Ashcroft test gauge model 450182As02L200# has been found to be satisfactory for this purpose. This gauge may be available through Grainger (Stock No. 2F008).

Appendix (Nonmandatory Information)

A1. Calculation of Beam Specimen Volumes

A1.1 Volume of mix needed to make a beam at 7 % air voids:

(Volume of Mold) x (Rice Density) x (0.93)